THE PHD.™ TELECOMMUNICATOR

OPERATOR'S MANUAL

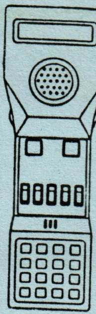

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TABLE OF CONTENTS

SECTION 1 - GENERAL

1-1 Introduction

The PHD telecommunicator is an enhanced test set which integrates all of the features provided by an ordinary Butt-Set with a hands-free monitoring device, a speakerphone and a digital multimeter in one compact, portable device.

In addition to these features, the PHD also contains Ziad's exclusive DIGIT DISPLAY which captures and displays the values of all tone and pulse dialed digits, including on/off time and dB levels (for tones) or % break, pulses per second and interdigit time (for pulses). The DIGIT DISPLAY also monitors the line status (on-hook/off-hook), zero volt intervals and non-DTMF voice band tones.

Due to the sophisticated nature of the PHD, a thorough understanding of this manual is required before attempting operation. **(Failure to understand the interaction of various features could result in potential damage to your unit.)**

1-2 Unpacking the Unit

Each PHD is shipped from the factory in a corrugated carton that contains an inner carton made of high-impact double-wall plastic. This foam lined plastic case has a handle and is designed to be used as a permanent carrying case for the unit. Although the PHD provides the same features as most Butt-Sets, it is actually a complex, microprocessor based, electronic device and should be treated accordingly. We strongly suggest that the unit be kept in its carrying case when not in use. Also included with each PHD is one fuse, type 3AG ¼ amp (already installed in the fuse holder of the unit), one set of batteries, type AA alkaline and this manual. Please check to make sure all items were shipped with the unit before proceeding.

1-3 Installing the Batteries

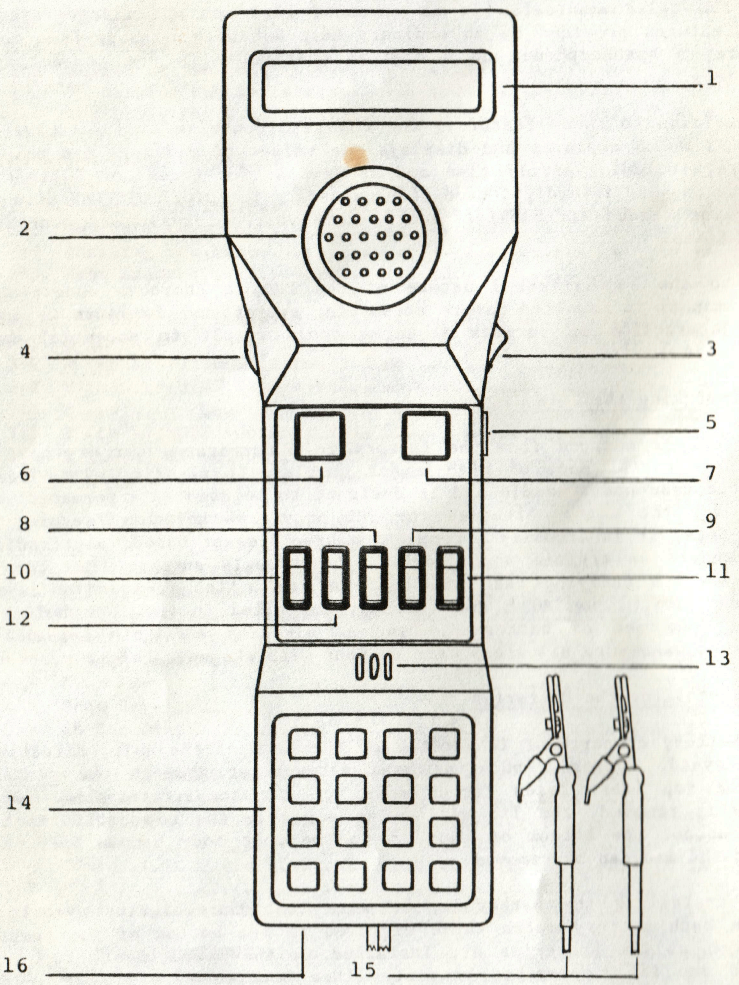
The battery compartment is located on the back of the unit, directly behind the keypad. Using a phillips head screwdriver, remove the single screw at the top (test leads facing down) of the compartment lid. Once this screw is removed, the lid will swing out from the top until the two tabs that anchor the bottom of the lid to the unit body become free, at which point the lid can be removed.

When installing the batteries, be sure that the polarity symbols (+ and -) on each battery match those engraved in the bottom of the compartment. As soon as the batteries are installed in the compartment, turn the unit on to see if it operates properly (See Section 2). If not, remove the batteries promptly as they could be damaged if left in an incorrect position for a prolonged period of time.

When replacing the batteries in the future, use only high quality alkaline cells like those originally supplied with the unit. These cells have a lower impedance than conventional cells and will guarantee better operation of the PHD's sensitive audio circuits. In addition, alkaline cells are generally cheaper on a per-hour basis.

Never leave discharged batteries in the PHD for prolonged periods of time as they may leak and damage the unit. If lengthy storage of the PHD is required, remove the batteries regardless of age or charge.

FIGURE 1



1. Liquid Crystal Display
2. Speaker/Earpiece
3. Talk/Monitor Switch
4. On-Off/Volume Control
5. Fuse
6. Clear Key
7. Scan Key
8. Digit Display/DMM
9. Normal/Hands-free
10. DC/AC
11. Tone/Pulse Dialing
12. V/mA
13. Microphone
14. 16 Digit Keypad
15. 66 Block Test Clips
16. Battery Compartment

1-4 Replacing the Fuse

The fuse holder is located on the right side (display facing you) of the hand grip.

Insert a small screwdriver or your fingernail into the slot on the fuse holder cover and gently push in while rotating the cover one-quarter turn to your left (or counter clockwise). Release the pressure and the entire fuse assembly will be released and can easily be removed. Remove the fuse from the fuse holder assembly and replace with a new 3AG ¼ amp type. **Never replace with a larger fuse as serious damage to the PHD may occur.)**

SECTION 2 - BASIC OPERATION

2-1 Power-On Sequence

Before turning the PHD on, take several minutes to acquaint yourself with the location of each item shown in Figure 1. Once you have done this, turn the PHD on by rotating the thumbwheel **ON-OFF/VOLUME** control, located on the left side of the unit (display facing you), down or counter-clockwise. You should immediately hear a positive "click" from the thumbwheel control which indicates the **ON** position has been reached. You need not rotate this control any further at this point. As soon as power is applied to the unit, the sign-on messages should appear on the Liquid Crystal Display (LCD). There are two (2) messages in all, lasting one (1) second each. These messages will appear as follows:

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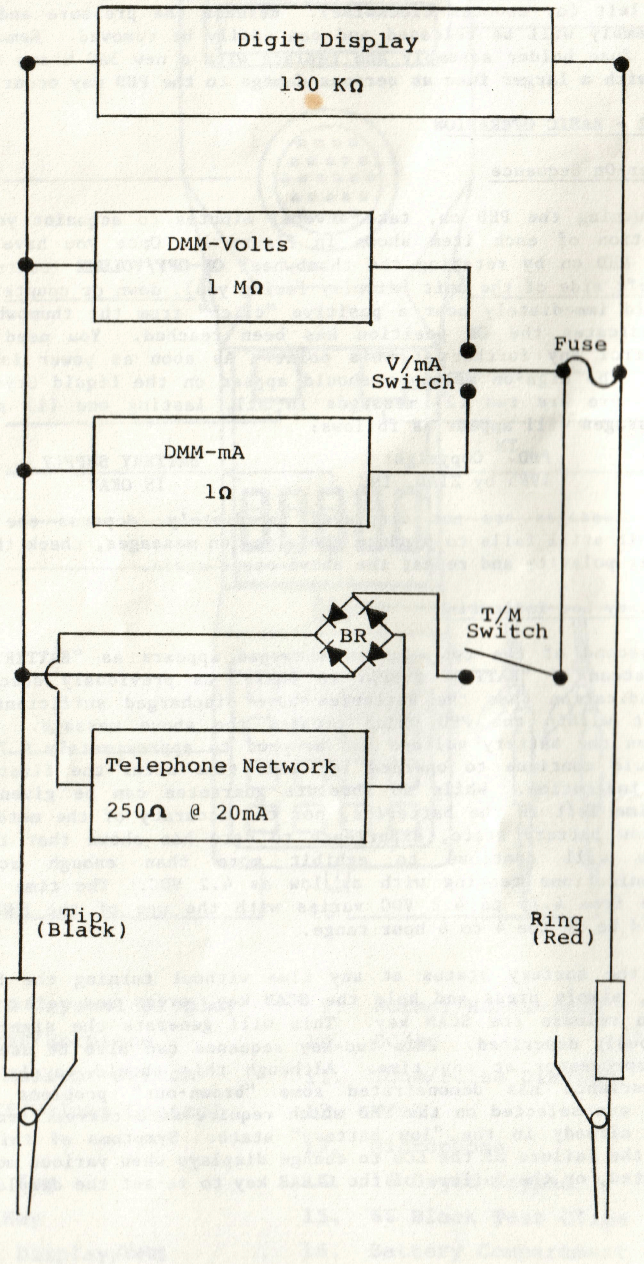
If these messages are not displayed immediately, depress the **CLEAR** key. If the unit still fails to produce the sign- on messages, check the batteries for proper polarity and repeat the above steps again.

2-2 Battery Low Indication

If the second of the two sign-on messages appears as "BATTERY SUPPLY IS LOW" instead of "BATTERY SUPPLY IS OKAY." as previously described, this is an indication that the batteries have discharged sufficiently to trip a circuit within the PHD which creates the above message. This should occur when the battery voltage has dropped to approximately 4.75 VDC. The unit should continue to operate for some time after the first appearance of this indication. While no absolute guarantee can be given as to the actual time left in the batteries, nor the accuracy of the meter functions in the low battery state, experience to date has shown that the majority of units will continue to exhibit more than enough accuracy for telecommunications testing with as low as 4.2 VDC. The time required to discharge from 4.75 to 4.2 VDC varies with the use of the PHD's features but should be in the 4 to 6 hour range.

To view the battery status at any time without turning the PHD **OFF** and **ON** again, simply press and hold the **SCAN** key, press and release the **CLEAR** key, then release the **SCAN** key. This will generate the sign-on messages as previously described. This two-key sequence can also be used to re-set the microprocessor at any time. Although this should rarely be needed, past experience has demonstrated some "brown-out" problems as certain functions are selected on the PHD which require more current from batteries that are already in the "low battery" state. Symptoms of this condition would be the failure of the LCD to change displays when various mode switches are selected, or the failure of the **CLEAR** key to re-set the display.

FIGURE 2



2-3 Switch Interaction

Before attempting to connect the test leads of the PHD to any voltage source, you should thoroughly understand the internal circuitry of the unit as controlled by the white front panel switches and the black right-side mounted switch.

Figure 2 is a block diagram that represents the three main connections that are made through the PHD between its test leads. Since the PHD was designed to be used as a telephone line test device, the DC resistance of each connection was carefully calculated to provide adequate sensitivity while insuring that the total loop resistance of the line is not affected by the presence of the PHD. While this is true for the **Digit Display** and **DMM-Volts** circuits, which present a very high resistance across the line, the **DMM-mA** and the **telephone network** behave in the opposite manner since they present a very low resistance across the line. Both of these circuits will allow enough current to flow through the PHD to blow the fuse if connected to a voltage source without adequate series resistance. Since all telephone lines have built-in resistance that effectively limits current flow, you should never have to replace the fuse in the PHD if its use is limited to this area.

While you may use the PHD to measure non-telephone line voltages and currents, you should do so only after reading the remainder of this manual. You should also have a good general understanding of Ohm's Law as it relates to series and parallel resistances.

Regardless of the application, it is a good idea to leave all five (5) of the front panel switches and the single right-side switch in the "up" position (toward the display) between feature selection. By restoring the switches to this position at every opportunity, you will become accustomed to this appearance as the "normal" mode for each switch and will be less likely to leave any switch in a position that could blow the fuse when the unit is connected to a different source. In addition to being a good safety precaution, you should find that the "up" position for each switch will provide the feature selection that is used the majority of the time.

2-4 Checking the Fuse

The PHD was designed in such a way that only those portions of the device that might be harmed by high currents are fused. This means that the PHD will still be a useful tool should you accidentally blow the fuse without a replacement handy. Specifically, the **Digit Display** and the audio monitor, including both **NORMAL** and **HF** modes, will continue to work properly (See Sections 4 and 3). The **DMM** displays will appear in their proper format when selected but will exhibit no reading (with the exception of **DC-VOLTS** which may read 1.5 or less due to the fact that some circuitry is shared with the **Digit Display**).(See Section 5). The most obvious symptom of a blown fuse, however, is the loss of the Butt-Set features including the ability to seize the line or dial in either **Tone** or **Pulse**. (See Section 3). Should your PHD exhibit any of these symptoms, replace the fuse as previously described in Paragraph 1-4.

2-5 Test Leads

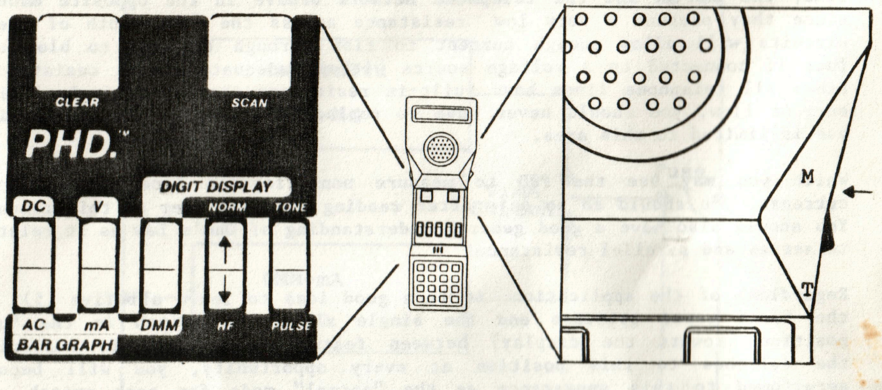
The PHD is equipped with a pair of industry standard Butt-Set type test leads that terminate in 66 block clips. As is typical of most other sets, the red lead is the ring side of the line (easily remembered by saying ("red is ring") and the black lead is tip or ground.

SECTION 3 - BUTT-SET FEATURES

3-1 **M** (monitor) Mode - General

Figure 3 shows the location of the **T/M** (talk/monitor) switch on the right hand side of the unit. When this switch is placed in the **M** position, the PHD represents a high DC resistance and AC impedance to the telephone line (See Section 6). This is desirable for monitoring line status and audio activity without significantly influencing either. However, this is only true if the **V/mA** switch is in the **V** position. In the **mA** position, this switch will place a 1 ohm resistor in parallel with the monitor circuit, effectively shorting it and the telephone line at the same time (See Section 5).

Figure 3



3-2 **M** (monitor)/**NORM** (normal) Mode

This mode is selected by placing the **NORM** (normal)/ **HF** (hands-free) switch in the **NORM** position. This will fix the volume of the speaker at a level which will allow the PHD to be used in a similar manner as other Butt-Sets, with the speaker placed to the ear. This mode is best used for quiet monitoring where you do not want others to hear the monitored call.

3-3 **M** (monitor)/**HF** (hands-free) mode.

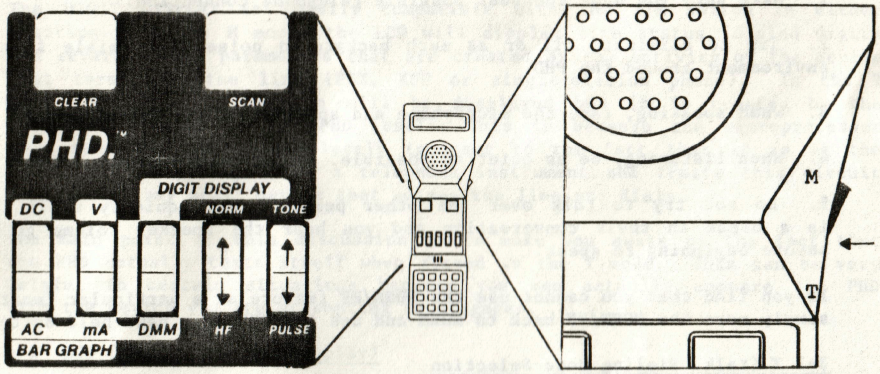
This mode is selected by placing the **NORM** (normal)/**HF**(hands-free) switch in the **HF** position. This will allow the volume of the speaker to be adjusted by using the thumbwheel **ON-OFF/VOLUME** control located on the left side of the unit. The PHD can then be placed on any flat surface or propped-up in its carrying case to provide hands-free monitoring of the line. This mode is best used in situations where you need to check something or make an adjustment at the opposite end of the telephone room while continuing to monitor the line, or when more than one person needs to listen to line activity.

One word of caution: The volume of the PHD in this mode may surprise you. To keep from accidentally broadcasting a monitored call beyond your immediate area, it is a good idea to turn the volume all the way down before selecting the **HF** mode.

3-4 **T** (talk) - General

Figure 4 shows the correct position of the **T/M** (talk/monitor) switch with the PHD placed in the **T** mode. This switch setting will place the voice hybrid network, tone dialer and pulse dialer across the telehone line to allow outbound calling. Collectively, these circuits exhibit a low DC resistance (See Section 6), which will allow adequate current to flow in the loop to trip the off-hook indicator and dial tone generator in the telephone switch. As previously described in paragraph 2-3, the **T** mode should never be selected when the PHD is connected to any voltage source other than a telephone line. When using the PHD as a **DMM** to read the voltage of any non-telephone line source (See Section 5), be sure to check the **T/M** switch to see that it is in the **M** position before connecting the test leads. This warning applies even if the **ON/OFF volume** control is **OFF**. Failure to check this switch when using the PHD in this manner could result in a blown fuse or a damaged unit.

Figure 4



3-5 **T**(talk)/**NORM** (normal)Mode

This mode is selected by placing the **NORM** (normal)/**HF** (hands-free) switch in the **NORM** position. This will fix the volume of the speaker at a level which will allow the PHD to be used in a similar manner as other Butt-Sets, with the speaker placed to the ear. This mode is best used for quiet conversation where you do not want others to hear the called party.

3-6 **T** (talk)/**HF** (hands-free) Mode

This mode is selected by placing the **NORM** (normal)/**HF** (hands-free) switch in the **HF** position. This changes the PHD from typical Butt-Set usage into a full-featured, hands-free speakerphone. The speaker volume may be adjusted by using the **ON-OFF/VOLUME** control, while the microphone level is controlled by internal circuitry for the best overall performance.

As with all speakerphones, you will notice a slight delay after you stop talking before you hear the speaker volume return to the adjusted receive level. This is due to the fact that the speaker and the microphone cannot be connected to the line at the same time because they would feed back continuously. To overcome this problem, all speakerphones have a circuit that switches these components in and out based on a determination of which party is speaking and which party is listening. This determination is made by comparing the level of sound occuring on the telephone line with that of the microphone. The slight delay that is heard is due to a timeout circuit that decides when to make the transition from one mode to the other.

Although circuits associated with this feature have been designed to provide the best possible operation in most situations, you may experience either "cutting in and out" or "excessive delay."

"Cutting in and out" is generally caused by low voice and/or high noise on the telephone line where very little difference is detected in level between talking and listening. If this occurs, try calling back in hopes of finding a cleaner circuit.

"Excessive delay" is generally caused by consistant, but not necessarily loud, background noise in the immediate vicinity of the PHD. If this occurs, try turning off any noise-producing devices such as radios, copiers or typewriters, if possible.

Even if you do not experience either of the above problems, speakerphone performance is always improved by following several basic rules:

1. Make sure you have the best possible telephone connection.

2. Try to eliminate all or as much background noise as possible from the environment around the PHD.

3. When speaking, face the microphone and speak firmly.

4. When listening, be as quiet as possible.

5. Do not try to talk over the other person. Wait quietly until there is a break in their conversation and you hear the speaker volume go down before beginning to speak.

If you find that you cannot use the **NORM/HF** feature at a particular location, simply move the **NORM/HF back to NORM** and use the PHD as a hand-held Butt-Set.

3-7 T (talk) Dialing Mode Selection

Figure 4 shows the location of the **TONE/PULSE** switch which is used to select the type of dialing provided by the PHD. When placed in the **TONE** position, the PHD will dial in **DTMF**. All sixteen (16) keys on the keypad are active in this mode, with the character set consisting of the twelve (12) standard telephone characters of 1 through 0, *, and # plus the four characters on the right hand side which are labeled as A,B,C and D (typically called 4th column or military tones.)

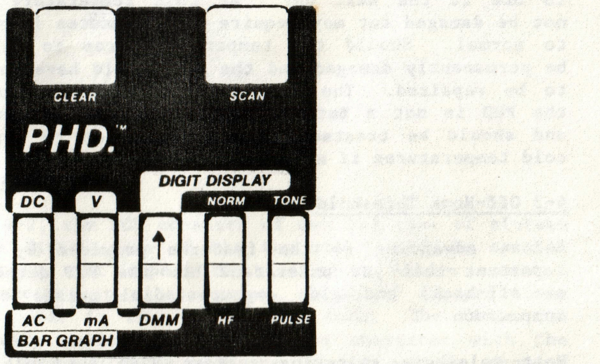
When placed in the **PULSE** position, the PHD will generate precise dial pulses at a rate of twelve (12) pulses per second, with a break cycle of 60%. Only ten (10) keys are active in this mode, with the available character set consisting of the standard rotary dial telephone numerals of 1 through 0

SECTION 4- DIGIT DISPLAY FEATURES

4-1 General

Figure 5 shows the location of the **DIGIT DISPLAY/DMM** switch in the middle of the five (5) switches that are mounted in the front panel of the hand grip portion of the PHD. This switch serves two purposes: it acts as a hardware flag that tells the microprocessor to look at the **DIGIT DISPLAY** or the **DMM** circuitry and it disconnects the **mA** portion of the **V/mA** switch to provide extra protection against accidental use. Since this switch does not disconnect the **DIGIT DISPLAY** or **DMM-V** circuits when it is in the opposite position,these circuits exist in parallel, but still present a very high DC resistance and AC impedance to the line. (See Section 6).

Figure 5



The DIGIT DISPLAY is totally compatible with the **T/M** switch in either position. In the **M** mode, the LCD will display line status, dialed digits and several other parameters that are created by the activity of the device that terminates the line (PBX, KSU or single-station phone). In the **T** mode, the same information will be displayed but it is created by the Butt-Set features of the PHD itself. This is because the microprocessor that runs the LCD is completely ignorant to the fact that it is in the same physical package with a telephone instrument and treats this circuit the same as any other device that seizes the line and dials.

The main point of this discussion is to make you aware of the fact that the PHD actually tests itself when placed in the **T** mode. This can be very helpful in certain situations because you can actually compare the PHD with the device you are attempting to diagnose.

4-2 LCD (Liquid Crystal Display)

This display consists of two (2) rows of sixteen (16) characters each. Each character is made up of five (5) by seven (7) dot matrix which provides for greater resolution than many LCD's and also allows the use of the full range of standard typewritten characters, which makes it easy to read and understand. Several of the other digit analyzers on the market use a seven (7) segment display which is basically limited to the characters 1 through 0. As an example of the disadvantages of this type display, consider that the DTMF character "#" must be displayed as a "C". By contrast, the PHD displays all DTMF characters exactly as they appear on the telephone keypad. In fact, the LCD used in the PHD is so versatile that it contains five (5) custom characters that were created specifically for the unit. These will be described in detail in a later paragraph in this same section.

There are, however, several things that make LCD's in general, less than perfect for portable devices. First, they tend to be difficult to read in very bright light, such as sunlight, or in very dim light. Even in correct lighting, the angle of the light to the display may cause a glare, while the angle of the display to you may cause it to appear rather dark. Although there is no total cure for this problem, the PHD employs some new technology in photochemically treated plastics in the display cover window, which helps a great deal. However, there is no substitute for simply moving the PHD around until the display is easiest to read.

The second problem involves the LCD's sensitivity to cold. If you leave the PHD in your car overnight and the temperature falls to between 32°F

and 0°F, you will find that the display will be very dark when you attempt to use it the next day. At this temperature range, the display should not be damaged but may require a few minutes in a warm room before returning to normal. Should the temperature drop to below -4°F, the display may be permanently damaged and the unit would have to be returned to the factory to be repaired. The best solution to this problem is to recognize that the PHD is not a Butt-Set, it is a complex piece of electronic equipment and should be treated as such. Try not to expose the unit to extremely cold temperatures if at all possible.

4-3 Off-Hook Threshold

Before advancing to the features provided by the **DIGIT DISPLAY**, it is important that you understand how the PHD determines the line status (**on or off-hook**) and also captures dial pulses by using a simple voltage comparison.

Most telephone switching systems supply a talk battery within the range of 45-55 VDC. If loop extenders are added, this may increase to as much as 85 VDC, while some small town switches, as well as many PBX's, provide only 24 VDC. In all of these cases, the telephone instrument only needs 5 or 6 VDC for adequate operation. The remaining voltage is dropped across the internal resistance of the switching system and the copper wire pair that connects this system to the telephone. The only important component of this equation is the amount of current flowing in the complete loop. Most single-station telephones require at least 20mA for satisfactory operation. Therefore, the amount of voltage that a switch provides is mainly dependent upon the average distance between the switch and the telephone. Once this is understood, it is easy to see why most switches that are located in heavily populated urban areas supply the 45-55 VDC needed for loops of four (4) miles or less, while switches that provide service to rural areas may need loop extenders for loops of up to eight (8) miles, with small town switches and PBX's needing only 24 VDC supplies for loops of 1000 feet or so.

If a voltage meter is placed across a typical telephone pair, the voltage read in the **on-hook** state will be the entire supply of the switch due to the fact that the telephone is providing an open in parallel with the meter. When the telephone closes the loop, causing current to flow, the line is now considered **off-hook** and the voltage read across the line depends entirely on where you are located on the loop. If the supply of a certain switch is 48 VDC and the meter is placed at the point where the outside plant wiring is connected to the switch, the reading taken could be as high as 36-40 VDC due to the fact that the meter is in parallel with the entire loop external to the switch, including the telephone. On the other hand, if the meter is placed directly across the phone at the customer location, the reading could be as low as 5 VDC since only the small resistance of the telephone is in parallel with the meter.

The PHD uses exactly this technique to determine the **on-hook/off-hook** status of the line and to capture dial pulses, which are nothing more than a rapid pattern of on and off-hook transitions called break and make cycles. However, since the PHD was designed for use at the switch site as well as the customer location, the voltage reference that is compared to the line voltage must be adjustable. This is accomplished by using a small screwdriver to turn the off-hook threshold potentiometer which is located on the back of the unit directly behind the speaker. This pot is adjustable from approximately 9-45 VDC which should provide an adequate range for any application. Figure 6 shows the location of the highest and lowest reference points on the pot. The factory setting is 18 VDC which is sufficient for use at most customer locations, including 24 VDC supplies. Switch site usage may require a higher setting, but once it is set it should not need future adjustment. The procedure for setting this reference by

using the display is described later in this section along with the custom line status character.

Figure 6

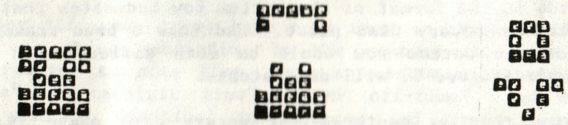
4-4 Display Format and Operation

As mentioned in paragraph 4-2, the LCD consists of two (2) rows of sixteen (16) characters each. The first space of the top row (left) is special and the three (3) characters that appear in this space behave somewhat differently from other characters in other spaces. Figure 7 depicts these three characters as they appear in true dot matrix form. The first two (2) examples are collectively called the Line Status character with the first example showing the **on-hook** state and the second example showing the **off-hook** state. As you can see, this character resembles a telephone with the handset moving up and down to indicate line status. As mentioned in paragraph 4-3, this character is controlled by a comparison of the voltage across the line with an internal voltage reference that is set by the pot that is located on the back of the unit. If the Line Status character does not display the proper status, adjust this pot as follows:

1. Line is **off-hook**, character is **on.** This means that the voltage did not drop below the threshold. Turn the reference up by rotating the pot to the right (clockwise). When the character changes states, rotate the pot another 20° or so to make sure the reference is solid. This problem would most likely occur at a switch site.

2. Line is **on-hook**, character is **off.** This means that the voltage did not pass above the threshold. Turn the reference down by rotating the pot to the left (counter-clockwise). When the character changes states, rotate the pot another 20° or so, to make sure the reference is solid. This problem would most likely occur when a unit that has been used at a switch site is used at a customer location, or when a unit that has been set to 30 VDC for a 48 VDC supply encounters a 24 VDC supply.

Figure 7



Referring to Figure 7, the third character is called Zero Volt and is present in the first space when zero volts of potential exists across the test leads. This will occur when the test leads are not connected to anything, or on idle ground start trunks. This character may also be displayed at other places in a call record, as will be discussed in paragraph 4-6.

The unique thing about the first space of the top row, in addition to the previously discussed fact that only three characters are ever displayed there, is that those three characters will erase and replace each other in the same space. This behavior will not occur at any other space on the display, since the purpose of the remainder of the spaces is to capture and retain data about each event that occured during the progression of a call.

The operation of this display is very much like a typewriter, with each event character filling the next space to the right. The display cursor (a small line under the character) is left under the last character that was displayed, until the next event creates the next character. This continues until all thirty-one (31) spaces are full, at which point the display software will cease the accummulation of data and will not "wrap around" or "write over" previously displayed data.

There is one last item that should be mentioned concerning the operation of the display. As you begin to familiarize yourself with the **DIGIT DISPLAY**, you will notice that each event character is not written to the display until it has finished. This is due to the collection of timing data that will be explained in the next paragraph.

4-5 Event Parameters

Using the example once again of the event characters being written to the display as if they were being typed on a typewriter, imagine that the display software could keep track of the amount of time that each key was held down and the amount of time that elapsed from the point where the last key was released until the next key was pressed. This is exactly what the display software captures for the first fifteen (15) event characters that fill the top row of the LCD. The bottom row is used to display these parameters in three different formats, depending on the type of character that the cursor is sitting under. By using the **SCAN** key (see paragraph 4-7), you can view the parameters for each top row character on a space-by-space basis.

Figure 8

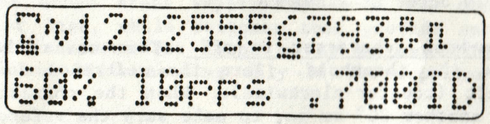


Figure 8 shows a completed call record that consists of fourteen (14) event characters which follow the **off-hook** status indication and fill spaces 2 through 15 of the top row of the LCD. If you will notice, the cursor is under the character 6. This means that the information associated with this character is currently displayed on the bottomm row of the LCD. In the case of the 6, the format of the bottom row indicates that this character was transmitted in rotary dial pulse. Had this 6 been transmitted in DTMF, the format of the bottom row would be much different in appearance, as the next example (Figure 9) will demonstrate.

The information that is captured for rotary dial pulse is: % of break, which is the % of the time the line was broken during one complete break/make cycle, the pulses-per-second, which is the number of complete pulse cycles that can be transmitted in one second, and the interdigit time, which is the time that elapsed from the end of the break period of the sixth pulse of the 6, to the beginning of the break period of the next rotary dial pulse character, or the beginning of an entirely new event character. The range of the interdigit timer is .001 to 9.9 seconds. In the above example, this time is displayed as .700, which equals 700/1000ths of a second, or 700 milliseconds. Note: The interdigit time is the only parameter that is displayed for a rotary dial pulse 1, since % break and PPS cannot be calculated for a single break.

Figure 9

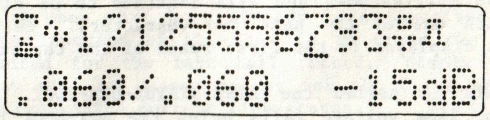


Figure 9 shows the same call record as Figure 8 but the cursor is now under the 7. Once again, the format of the bottom row indicates what method was used to transmit the character, which in the case of the 7, was DTMF.

The information that is captured for DTMF is: on/off time, which is the amount of the time that the tone was present on the line, followed by the elapsed time from the end of this tone to the beginning of the next DTMF tone or the beginning of an entirely new event, and the dB level of the tone. The range of the on/off timer is .001 to 9.9 seconds. In the above example, both the on and the off times are displayed as .060, which equals 60/1000ths of a second, or 60 milliseconds. The range of the dB function is -24 to OdB (relative) and is read exactly as displayed.

Figure 10

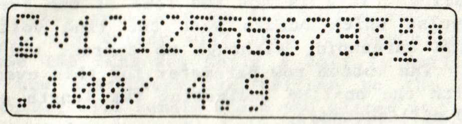
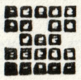


Figure 10, once again, shows the same call record as Figures 8 and 9 but the cursor is now under one of the PHD's custom characters, known as the Zero Volt Interval. Since this character is not a tone, no dB level is displayed. Therefore, the only information that can be captured is: on/off time, which is the amount of time that the Zero Volt Interval was present, followed by the elapsed time between the end of the event and the beginning of the next. The range of this timer is .001 to 9.9 seconds. In the above example, the event is displayed as lasting .100, which equals 100/1000ths of a second, or 100 milliseconds, while the off time is displayed as 4.9 and is read as 4.9 seconds.

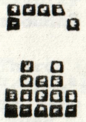
Although many different terms have been used in this section, all of which mean different things depending on the context in which they are used, it is interesting to note that, from an electrical standpoint, the terms "make cycle", "interdigit time"," DTMF off-time" and custom character "off-time" are all identical in function and simply mean that there is a stable DC voltage dropped across the test leads of the PHD that is below the **off-hook** threshold and has no appreciable AC component.

4-6 Custom Characters

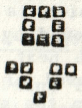
As previously mentioned, any character that has a numerical value of 1-0 is a dialed digit that was transmitted in either rotary dial pulse or DTMF. The difference can be determined by the format of the bottom row parameter display. In addition, the DTMF characters *, #, A,B,C and D are displayed exactly as they appear on the keypad. The other five (5) characters that may appear on the display are custom characters that were created especially for the PHD. Each of these characters is created by a specific event that occurs during typical telephone line usage. The definition of each character and the associated event that creates it is as follows:



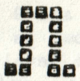
This is called the **LINE-STATUS-ON-HOOK.** This occurs whenever the line voltage rises above the **OFF-HOOK** threshold for at least 150 milliseconds and will continue to be displayed until replaced with one of the next two characters. This character will only be displayed in the first space of the top row.



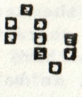
This is called the **LINE-STATUS-OFF-HOOK.** This occurs whenever the line voltage falls below the **OFF-HOOK** threshold for at least 100 milliseconds and will continue to be displayed until replaced by either the **ON-HOOK** version of this characater (above) or the **ZERO VOLT INTERVAL** (next). This character will only be displayed in the first space of the top row.



This is called the **ZERO VOLT INTERVAL.** This occurs whenever there is less than 3 volts of potential across the line for at least 50 milliseconds. This character may be present in the first space of the top row if the display has been cleared (See 4-7) and the test leads are not connected to anything or are connected to an idle ground start trunk. This character may also be present at any other space on the display which will indicate that the telephone switch battery has been removed from the line. This occurs regularly on most switches just before dial tone is generated or as the call is switched after completion of dialing. This is not the same as the break cycle of a rotary dial pulse which occurs when the line voltage rises above the **OFF-HOOK** threshold, although no current will flow during either event. The bottom row parameter for this event is shown in Figure 10, with the on-time indicating the length of the event (usually 50-150 milliseconds).



This is called the **LONG PULSE INTERVAL.** The criteria for this event is the same as the **LINE STATUS ON-HOOK** (above) but it is displayed in the call record at the point where it occurred. This character is usually created by a hook-flash or a legitimate **ON-HOOK** which may last any length of time. In this second case, you will only see this character if you do not clear (see paragraph 4-7) the display before a new **OFF-HOOK** occurs,due to the fact that characters are not displayed until an event ends. The bottom row parameter for this event is shown in Figure 10, with the on-time indicating the length of the event. Frequently this time will be shown with an up-arrow in front of 9.9 seconds, since this is the limit for this timer.



This is called the **IN BAND TONE INDICATOR.** The criteria for this event is the presence of any non-DTMF tone on the line for at least 500 milliseconds, that is between 300-3000 HZ and has a level of at least -24dB which does not fluctuate more than 3dB. This character is usually created by dial tone or ring back. In this second case, the software will not allow consecutive characters of this type to be displayed next to each other. Instead, a single character will be shown but as soon as the first tone has ended, the on-off time of the bottom row parameter will begin to toggle back-and-forth with each new ring. This feature keeps the display from being filled with ring-back signals. The format for the bottom row parameter is the same as for DTMF, as shown in Figure 8, with the on-off time indicated for the last cycle only.

4-7 CLEAR KEY

This key has several uses that have already been described in Section 2. However, the primary function of this key is to clear the display of all data that was captured for the last call record. Simply press this key once and the display will be erased except for the first space of the top row which always indicates the current line status.

4-8 SCAN KEY

Until now, the DIGIT DISPLAY has been discussed in terms of "real time." While it is true that this feature operates with only a slight delay that is caused by the need to wait for timing data, many events simply occur too fast to allow the bottom row parameters to be adequately reviewed. By using the **SCAN** key, you can review previously stored data during the progress of a call or after completion.

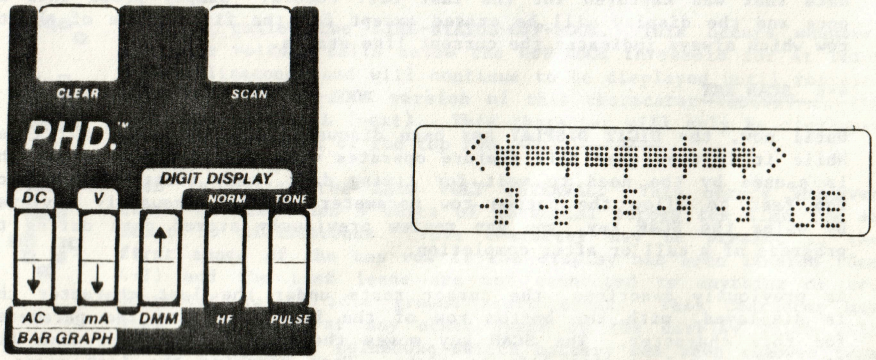
As previously described, the cursor rests under the last character that is displayed, with the bottom row of the LCD indicating the parameters for this character. The **SCAN** key moves the cursor one space each time it is depressed, moving left to right. Upon reaching the last space of the top row, it will move to the first space of the bottom row and then return to the second space of the top row, at which time the parameters for that character will re-appear on the bottom row. If the display is not completely full, the cursor will skip all empty spaces for a faster return. If you use the **SCAN** key while a call is still in progress, you will notice that new characters are written to the display in proper sequence, but the cursor will remain where you placed it, with the parameters for that character displayed on the bottom row of the LCD. The parameters associated with these new characters that are displayed during the **SCAN** process have not been lost but have been placed in memory. To view these parameters, simply move the cursor under each character and they will appear on the bottom row.

As you may have noticed, the complete cursor cycle around the LCD seemed to stop on the first space of the bottom row without reason. If you will recall, this complete cycle is only required if the display is "completely full." Up until now, we have discussed this top row as displaying event characters and the bottom row as displaying event parameters only. While this is true for the first fifteen (15) characters (full top row), the bottom row serves a second purpose should a sixteenth (16th) character be created. If this occurs, the bottom row will begin to display event characters until full (16 characters). However, no event parameters are captured for these bottom row characters. This is why the cursor only stops at the first space of the bottom row. Since these characters have no parameters associated with them, there is no need for the cursor to move under each one. Instead, it simply stops at the first space and displays the entire row of characters before returning to the second space of the top row.

4-9 dB BAR GRAPH

Figure 11 shows the correct front panel switch positions required to select this feature. As you will notice, the **AC/DC** and **V/mA** switches appear to be set to **AC** and **mA.** These switches actually serve a dual purpose and select **dB BAR GRAPH** when the **DIGIT DISPLAY/DMM** switch is set to DIGIT DISPLAY. Be sure that this switch is set properly to avoid placing the 1 ohm **mA** measuring circuit across the line, which would occur if this switch is accidentally set to **DMM.**

Figure 11



This display feature is produced by the same circuit that produces the bottom row event parameter of dB for tones. This display is completely interactive with the **DIGIT DISPLAY** and may be viewed while new characters are captured and retained in memory for review with the **SCAN** feature after returning to **DIGIT DISPLAY** from **dB BAR GRAPH.**

The purpose of this feature is to provide a "real time" visual indication of tone level activity. Figure 11 shows the display format for this feature,which has a large bar that moves from left to right as the signal level increases. The scale for this meter is calibrated in **3dB** steps with the -27, -21, -15, -9 and -3 steps displayed. The blocks between these steps do not have their value displayed on the scale due to lack of room, but are -24, -18, -12 and -6. In addition, any reading of **0dB** or greater is indicated by a right-hand arrow, while tones less than **-27dB** cannot be detected and are indicated by a left-hand arrow.

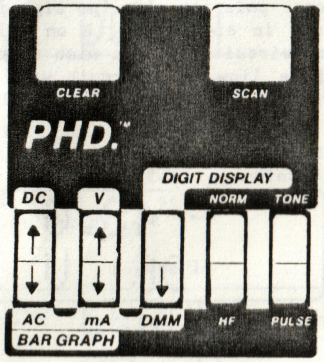
The circuit that determines these levels is generally called **dB** (relative). However, if the device that terminates the telephone line has an **AC** impedance of 600 ohms at the appropriate test tone frequency, then the meter can be read as **dBm.** The PHD Butt-Set feature **(T)** was designed to present a 600 ohm AC impedance for good voice quality and can be used to terminate the line for this purpose, however, the accuracy of any reading taken cannot be guaranteed due to the fact that the microphone cannot be muted.

SECTION 5- DMM FEATURES

5-1 General

Figure 12 shows the location of the three (3) front panel switches associated with the **DMM** features of the PHD. As indicated, the **DIGIT DISPLAY/DMM** switch must be set to **DMM,** while the **AC/DC** and **V/mA** switch may be set in various combinations to select the desired function. As stated in Sections 2 and 3, extreme caution must be exercised before using this function. This is particularly true if you are dealing with a voltage source other than a telephone line. In this case, you should definitely make sure that the **T/M** switch is firmly set to **M.**

Figure 12



The circuit that determines the readings for each function was designed to be fully autoranging throughout the .1 to 199.9 range (**V** or **mA**). Bearing in mind that the PHD is intended primarily for use on telephone lines, a slight compromise was made in accuracy to accommodate this autoranging function. The stated accuracy of this circuit must be + or -1% of the full scale in any mode. However, actual testing to date indicates that the average unit possesses a greater degree of accuracy than expected. While we cannot guarantee better results than our stated accuracy, we would suggest that you compare your PHD with another high-quality meter to determine what difference exists between the two. If you perform this experiment, you should notice the greatest offset at the very low range of 3 or less. You may also notice a small offset within the PHD itself when taking opposite polarity readings in this range, using the same source. Nevertheless, we are satisfied that the accuracy of the PHD is more than adequate within the range that would typically be required to perform testing on most telephone lines.

Another subject that needs explanation is the color coding of the test leads. As mentioned in Section 2, the test leads of the PHD are color-coded according to industry standards ("red is ring"). Since both the Butt-Set features and the **DMM** features are served by the same set of test leads, the color-coding is common to both. Since the standard for **DMM** test leads is that red is the most positive, the PHD was designed to comply with this standard. This may confuse some persons when taking a reading on a telephone line because the ring side of the line should be the most negative of the pair, which means that the PHD will provide a negative reading. Actually, this turns out to be correct since the black lead of a **DMM** should always be connected to ground and the tip side of the line is the ground for the circuit. This means that the battery side of the line, or ring, is at a negative voltage with respect to ground, or tip. Therefore, any negative reading on a telephone line is the correct polarity.

If you take the suggestion offered in Section 2 of leaving the front panel switches in the "up" position as the "normal" mode, then simply moving the **DIGIT DISPLAY/DMM** switch to **DMM** will serve as a quick polarity check of the line. This is a great improvement over the old-style polarity button found on most other Butt-Sets, which draws significant current from the line and creates audible "clicks" that can be heard by the parties on a monitored line.

5-2 DC VOLTS

This mode is selected by moving the **V/mA** switch to **V** and the **AC/DC** switch to **DC**. The LCD will display the format shown in Figure 13 and the value will appear with proper polarity sign (no sign for positive, - for negative). This mode may be used in either **T** or **M** on telephone lines due to the high DC resistance of this circuit. If you wish to check the voltage of something other than a telephone line,this circuit will not be damaged, but be sure that the **T/M** switch is in **M** to avoid damaging the Butt-Set circuit or blowing the fuse.

Figure 13

```
- 48.0
DC  V
```

5-3 AC VOLTS

This mode is selected by moving the **V/mA** switch to **V** and the **AC/DC** switch to **AC**. The LCD will display the format shown in Figure 14 and the value will appear with proper polarity sign (no sign for positive, - for negative). This mode should only be used on telephone lines in the **M** switch position to monitor ringing voltage. While no damage will come to the unit from use on a telephone line in **T**, it is highly unlikely that any appreciable reading will be found. If you wish to check the voltage of something other than a telephone line, this circuit will not be damaged, but the **T/M** switch is in **M** to avoid damaging the Butt-Set circuit or blowing the fuse. However, take extreme care to make sure that you do not touch the exposed portion of the test clips as these were not designed to supply adequate insulation for measuring high voltages on lines that do not have significant series resitance. Proceed at your own risk.

Figure 14

```
105.9
AC  V
```

5-4 DCmA

This mode is selected by moving the **V/mA** switch to **mA** and the **AC/DC** switch to **DC**. The LCD will display the format shown in Figure 15 and the value will appear with proper polarity sign (no sign for positive, - for negative). Before selecting this mode, be sure that you have a good idea of what current level is to be expected. Please remember that this switch setting places only 1 Ohm of resistance between the test leads, effectively creating a "dead short" condition. Also remember that the fuse size is ¼ amp or 250 **mA** and can be blown by any voltage source that supplies as little as ¼ volt, provided that the current rating is high enough.

To take a current reading on a telephone line, you must be in series with the circuit. The best place to do this is to remove a bridging clip from either side of the line and place one test clip on each side of the gap created by the removal of the clip.

Figure 15

```
20.5
DC mA
```

5-5 ACmA

This is not a valid feature selection on the PHD. While no harm will come to the unit by accidentally selecting this instead of **DCmA**, the 1 Ohm **mA** circuit is connected by the **mA** switch regardless of the position of the AC/DC switch. Figure 16 shows the error message that will be displayed if the switch setting is selected.

Figure 16

```
*** ERROR! ***
AC mA
```

5-6 Over Range Indication

Should the measurement of either **V** or **mA** exceed the limit of the display, the indication shown in Figure 17 will appear in the space where the value is usually displayed

Figure 17

```
^200^
```

Section 6 - Specifications

6-1 Telephone Functions

1.	DC resistance -- MONITOR	115 Kohms
	DC resistance -- TALK	250 ohms @ 20 mA
	AC impedance -- TALK	600 ohms @ 1000 HZ
2.	Minimum voltage across tip & ring - TALK	3 VDC
3.	DTMF dial level	- 3 dBM @20mA
4.	DTMF twist	+ 3dB
5.	DTMF Frequency Deviation	+/- .75%
6.	Dial pulse dialing speed	12 PPS
7.	Dial pulse break %	60%
8.	Ringer Equivalency	0.0B

6-2 Digit Display Function

1.	Minimum DTMF receive time	40ms
2.	Minimum DTMF receive level	-27dBm
3.	Maximum DTMF receive level	OdBm
4.	Maximum Twist	(+/-) 10 dB
5.	Maximum Frequency Deviation	(+/-)1.5% (+/-)2Hz
6.	DTMF display ON/OFF time range	40 ms-9.9 seconds
7.	Minimum dial pulse receive rate	5 PPS
8.	Maximum dial pulse receive rate	20 PPS
9.	Minimum dial pulse receive break %	50%
10.	Maximum dial pulse receive break %	75%
11.	Minimum d/p receive interdigit time	100ms
12.	In-band Tone minimum presence	500ms
13.	In-band Tone minimum level	-24dB
14.	In-band Tone level deviation	3dB or less
15.	Long Pulse (hookflash) minimum presence	150 ms
16.	Zero volt minimum interval	50 ms
17.	Off-hook/Dial Pulse Threshold	adjustable 9-45 VDC

6-3 Digital Multi-Meter Function

1.	DC Voltage range	000.0-199.9 VDC
2.	AC Voltage range (all +/- 1% FS)	000.0-199.9 VAC
3.	DC Current range	000.0-199.9 mADC

6-4 Physical

1.	Size	10.25 x 3.25 x 1.5"
2.	Weight	24 oz.
3.	Case Material	High impact ABS
4.	Test leads	4'w/66 block clips
5.	Batteries	1.5 VDC AA (4)
6.	Fuse	3 AG type, 1/4 AMP
7.	Carrying case size	12" x 8" x 4"

Specifications subject to revision without notice

WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive.

Ziad, Inc. warrants each instrument it manufactures to be free from defects in material and workmanship under normal use and service for the period of 90 days from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries or any product or parts which have been subject to misuse, neglect, accident or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, Ziad, Inc. will repair and calibrate an instrument returned to an authorized Service Facility within 90 days of the original purchase provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within 90 days of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident, or abornal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be submitted before work is started, if requested.

THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS OR ADEQUACY FOR ANY PARTICULAR PURPOSE OR USE. ZIAD, INC. SHALL NOT BE LIABLE FOR ANY SPECIAL INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER IN CONTRACT, TORT, OR OTHERWISE.

If any failure occurs, the following steps should be taken:

1. Notify Ziad, Inc., or nearest Service facility, giving full details of the difficulty, and include the model number, type number, and serial number.

2. On receipt of the Return Merchandise Authorization, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

SHIPPING TO MANUFACTURER FOR REPAIR OR ADJUSTMENT

All shipments of Ziad, Inc. instruments should be made via United Parcel Service or "Best Way" prepaid. The instrument should be shipped in the original packing carton, or if not available, use any suitable container that is rigid and of adequate size. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT TO ORIGINAL PURCHASER

The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. Final claim and negotiations with the carrier must be completed by the customer.